COMPLIANT MODULAR JACK

REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 60/172,400 filed on December 17, 1999, and incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates generally to connectors for electronic communication devices. More specifically, the present invention relates to modular jacks for connecting to telecommunication lines.

BACKGROUND OF THE INVENTION

A vast majority of communication devices, such as telephones, facsimile machines, modems and local area network (LAN) adapters, require a wire connection to a telecommunication line. To conveniently attach a telecommunication line to a communication device, standard connectors have been promulgated. The most popular of these connectors is known in the art as the RJ-xx series of connectors. Of the RJ-xx series of connectors, the RJ-11, the RJ-12 and RJ-45 connectors are widely used. The RJ-11 connector comprises a six-contact plug and a corresponding jack, while the RJ-45 connector comprises an eight-contact plug and a corresponding jack. The RJ-11 and RJ-45 connectors are standardized in the industrial world and have desirable attributes of both low cost and high reliability.

Detailed information regarding the RJ-xx series of connectors can be found at Title 47 (Telecommunications), Code of Federal Regulations, Chapter I (Federal Communications Commission), Subchapter B (Common Carrier Services), Part 68

(Connection of Terminal Equipment to the Telephone Network), Subpart F (Connectors), Section 68.500 (1992) which is incorporated herein by reference in its entirety and referred to herein as "RJ-standards." Among other parameters, the RJ-standards provide for contact configurations having a minimum normal force and particular dimensions.

Although the RJ-standards provide for reliable and standardized connections, the applicants have identified that the relatively stout connectors mandated by the RJ-standard lack sufficient compliance to accommodate normal misuse. Misuse occurs, for example, when a user inserts an RJ-11 plug into an RJ-45 jack. Such an occurrence is not uncommon since these connectors are often used by people unfamiliar with the differences between the various RJ connectors which resemble each other. Such misuse unfortunately results in the housing around the RJ-11 plug permanently deforming the outer contacts of the RJ-45 connector.

The applicants have also identified that the lack of compliance of RJ-standard contacts results in limited durability due to the permanent deformation of the contacts after repeated mating cycles. According to the RJ-standard, a connector is rated only for 750 mating cycles. Although such a number may seem adequate, it is quickly reached by many users who may connect and disconnect their portable computers or other communication devices several times a day, every day, for several years. Indeed, it is not uncommon for a user to put a connector through 2,000 mating cycles or more in the life of the communication device. Thus, the RJ-standard of 750 mating cycles is woefully inadequate.

Therefore, there is a need for a modular jack connection which allows for normal misuse and provides for greater durability. The present invention fulfills this need among others.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a top perspective view of a communication card employing a modular jack assembly of the present invention;

Figure 2 is a front perspective view of the modular jack assembly shown in Figure 1;

Figure 3 is a back perspective view of the modular jack assembly shown in Figure 1 showing the card edge connector of the modular jack ready for insertion onto a circuit board;

Figure 4 is a front perspective view of a cross section of the card shown in Figure 1; and

Figure 5 is a back perspective view of the cross section of the card shown in Figure 1.

SUMMARY OF INVENTION

The present invention provides for a modular jack connector which allows for normal misuse and a high number of mating cycles by increasing the compliance of the contacts within the connector. It has been found that contacts with greater compliance tend to be more durable and more forgiving of misuse. To improve compliance, the connector has a novel configuration in which the contacts are anchored toward the back of the connector and extend forward such that their free end is toward the front of the connector. By having the end of the contact near the front of the connector free, the contact can accommodate a great deal of misalignment at the front of the connector where

such misalignment is most likely to occur. In addition to having a free front end, the contacts are configured to be more slender than those conforming to RJ-standards, thereby further improving their compliance. Despite deviating from RJ-standards, it has been found that the connectors of the present invention nevertheless provide adequate contact with standard RJ plugs.

Having the rear sections of the contacts secured to the housing also provides for an effective card-edge connector configuration. More specifically, the rear sections of the contacts may be mounted in the housing directly above a card edge-receiving slot to allow the ends of the contacts to extend into the slot. This way, the contact ends make contact with a circuit board when the modular jack assembly is mounted thereon. Such a configuration enables a single contact member to electrically connect the plug to the circuit board thereby eliminating intermediate circuitry and simplifying the modular jack assembly and its connection to the circuit board. Accordingly, this design lowers costs and increases reliability.

Accordingly, one aspect of the invention is a modular jack connector having contacts with high compliance relative to comparable RJ-type connectors. In a preferred embodiment, the connector comprises: (a) a dielectric housing having a front and rear orientation and defining at least one receptacle adapted for receiving a mating plug; and (b) a plurality of contacts disposed in the housing, each contact being secured to a rear portion of the housing, each contact extending forward from the rear portion to a free end such that a portion of the contact electrically connects with a mating plug when the mating plug is received within the receptacle. Preferably, the contacts are configured to provide sufficient compliance such that if an incorrect RJ-standard plug is inserted into the receptacle, the elastic limit of the contacts is not exceeded. To this end, the contacts

preferably are thinner and narrower than those conforming to RJ-standards and have a lower normal force than required under the standard.

Another aspect of the invention is a modular connector having a simple card-edge connector interface. In a preferred embodiment, the housing of the connector described above also comprises a slot on the rear end thereof suitable for receiving the edge of a circuit board. Each contact has a connection portion that extends through the housing and into the slot such that, when the housing is mounted to a circuit board, a portion of the connection portion makes contact with the circuit board.

Another aspect of the invention is a PCMCIA card comprising the modular jack connector of the present invention. In a preferred embodiment, the PCMCIA card comprises: (a) a housing; (b) a circuit board mounted in the housing; and (c) a modular jack connector assembly card-edge mounted to the circuit board, the modular jack assembly comprising: (i) a dielectric housing having a front and rear orientation and defining at least one receptacle adapted for receiving a mating plug; and (ii) a plurality of contacts disposed in the housing, each contact being secured to the a rear portion of the housing, each contact extending forward from the rear portion to a free end such that a portion of the contact electrically connects with a mating plug when the mating plug is received within the receptacle.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Referring to the drawings, Figure 1 shows a top perspective view of a communication card 1 comprising a modular jack assembly 2 of the present invention. It will be evident to those skilled in the art that although the invention is described herein with reference to a communications card and RJ-standard plug configurations, the modular

plug of the present invention is not restricted to RJ-type plugs and may be used in any application where a modular connector is connected to a circuit board.

A front perspective view of the connector assembly 2 is shown in Figure 2. As shown, the modular jack assembly 2 comprises a dielectric housing 6 having receptacles 3 and 4 on the front face thereof. Receptacle 3 is configured to receive an RJ-45 plug, while receptacle 4 is configured to receive an RJ-11 plug. In a preferred embodiment, the modular jack assembly 2 has light pipes 5 and 5a extending backward from the rear of the receptacles 3 and 4, respectively. The back ends 20 (only one shown) of light pipes 5 and 5a are positioned such that each aligns with an LED on the printed circuit board when the modular jack assembly 2 is mounted on a card to communicate light from the LED to the back of the receptacles. It should be understood that although the modular jack assembly 2 as shown in Figure 2 integrates two receptacles, the invention covers modular connectors having just one receptacle or two or more receptacles.

Within receptacles 3 and 4 are a plurality of contacts 3a and 4a, respectively. According to the RJ-standards, the RJ-45 receptacle 3 has eight parallel contacts and the RJ-11 receptacle 4 has six parallel contacts. The shape and positioning of the contacts within the receptacles and even the shape and dimensions of the receptacles themselves is governed by the RJ-standards and thus will not be addressed specifically herein.

Figures 4 and 5 show front and back perspective views of a cross-section of the card of Figure 1 taken through the receptacle 3 and along the length of one of the contacts 3a. Each contact comprises a plug-engaging portion 40 and a connection portion 10. The plug-engaging portion 40 is the portion of the contact that is disposed within the receptacle of the modular jack and is preferably flexible such that it deforms or deflects as a modular plug is received within the receptacle. The connection portion 10 of the contact is that

portion of the contact that electrically connects the modular jack to the printed circuit board of the communications device.

Figures 4 and 5 illustrate an important feature of the present invention, namely that the contacts 3a and 4a are secured to the rear of the housing 6 and extend forward to a free end 11. This provides for greater compliance at the front of the receptacle which is where greater misalignment is likely to occur between the receptacle and the mating plug.

These figures also illustrate another feature of the present invention, namely, the card edge connector of the modular jack assembly 2. More specifically, contacts 3a and 4a are secured to the housing 6 directly above a card edge-receiving slot 7 to allow the connection portions 10 of contacts 3a and 4a to extend into the slot. In this way, as shown in Figure 4, portions 12 of the connection portions 10 make contact with pads (not shown) of circuit board 8 (which is enclosed in the PCMCIA card 1 shown in Figure 1) when the modular jack assembly 2 is mounted thereon. In other words, the combination of the slot 7 and connection portions 10 of contacts 3a and 4a cooperate to act as a card edge connector suitable for receiving and electrically connecting with the edge 31 of circuit board 8. Such a configuration enables a single contact member to electrically connect the plug to the circuit board thereby eliminating intermediate circuitry and simplifying the modular jack assembly and its connection to the circuit board.

With reference to the specific embodiment of the invention shown in Figures 4 and 5, the free end 11 of the plug-engaging portion 40 of the contact is positioned within a slot 42 in the lower wall 41 of the receptacle. The free end 11 is connected to an upwardly angled section 43 that is positioned to engage with the modular plug when received within the receptacle. The upwardly angled section 43 is about 4 mm in length and extends from the free end 11 at an angle of about 30 to 45 degrees from the lower wall 41. An

elongated arm portion 44 is connected to the upwardly angled section 43. The elongated arm portion 44 is about 10.0 mm long and extends from the upwardly angled section 43 at an upward angle of between about 5 and 15 degrees from the lower wall 41. The elongated arm portion 44 is connected to the connection portion 10 of the contact. The connection portion 10 is anchored along a rear portion 45 of housing 6. The connection portion 10 is curved around the rear portion 45 to anchor or otherwise secure the contact to the housing. Preferably, the connection portion 10 extends into the slot 7 to a free end 12. The free end 12 resiliently engages an electrical contact such as a pad on the top surface of the circuit board 8 when the board edge is received within the slot.

Although not evident from the figures, the contacts 3a and 4a of the present invention are more compliant than RJ-standard contacts, not only because they have a free forward end 11, but also because they preferably are more slender than standard RJ contacts. For purposes of describing the dimensions of the contacts of the present invention to those of the RJ-standard, reference is made to the thickness t and width w of the contacts as shown in Figure 4. In the preferred embodiment, the thickness is about 25% to about 75% less than the applicable RJ-standard, and, more preferably, about 50% less, while the width is about 5% to about 15% less than the applicable RJ-standard, and, more preferably, about 10-12% less. For example, in an RJ-11- or RJ-45-style connector, it has been found that contacts with a thickness of about 0.005" to about 0.014" and a width of about 0.014" to about 0.016" are effective, and, for optimum compliance, a thickness of about 0.009" and a width of about 0.015" is preferred.

Because the contacts are less substantial than their RJ counterparts, a reduced normal force is also observed. Given the length, width and thickness of the contacts of the present invention, a normal force of less than about 25% to 80% of the applicable RJ-

standard is preferred, and a normal force of about 65% of the applicable RJ-standard is more preferred. For example, it has been found that a contact having a normal force of about 30g to about 50g is effective, and, for optimum compliance, a contact having a normal force of about 35g is preferred.

Despite deviations from the RJ standard, applicants have found that the performance of the contacts does not suffer. Indeed, as a result of being more compliant, the modular jack connectors of the present invention are rated for significantly more connections than are their RJ-standard counterparts. In a preferred embodiment, the connectors of the present invention are rated for at least about 1000 mating cycles, more preferably, for at least about 2000 mating cycles and, even more preferably, for at least about 3,000 mating cycles.

The compliance is sufficient such that if an RJ-11 plug is mistakenly inserted into an RJ-45 receptacle, the outer two contacts of the RJ-45 receptacle are not bent beyond their elastic limit. Consequently, when the mistake is noted and the RJ-11 plug is withdrawn, the outer two contacts of the RJ-45 receptacle return back to their normal, unmated position, without damage.